CHAPTER 1

INTRODUCTION

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Chapter One - Introduction

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1.1 Purpose

Providing adequate drainage in urban areas has been proven as a necessary component in maintaining the overall health, welfare, and economic well being of a region. Drainage is a regional feature that affects multiple jurisdictions and all parcels of land. It is important to develop drainage policy that balances both public and private considerations (UDFCD, 1969).

Certain underlying principles should be applied when planning drainage facilities. These principles apply to both water quantity and water quality management. Policy statements and technical criteria serve as the implementation tools for the underlying drainage principles (UDFCD, 1969).

The purpose of this Drainage Criteria Manual, in conjunction with the development of overall master planning of the major watersheds throughout the Lincoln, Nebraska area, is to provide drainage facilities in urban areas that avoid the disruption of the community while improving the overall health and welfare of the region in an economic way.

1.2 Contents

This Drainage Criteria Manual has been prepared for the City of Lincoln, Nebraska and the Lower Platte South Natural Resources District (LPSNRD) to provide guidance to design engineers, hydrologists, water quality specialists, and others involved in the management of stormwater runoff. An extensive collaborative effort was undertaken in the Manual preparation that involved input from a project Management Committee, Advisory Committee, and the general public. The committees were formed to represent a broad and diverse group of interests throughout the City, including: builders, developers, environmental groups, public works, neighborhood associations, etc. Meetings and workshops were regularly held to discuss and reach consensus on important drainage, flood control, and water quality protection issues specific to the City of Lincoln.

The Manual is comprised of nine technical chapters that provide guidance on the major aspects of urban stormwater management and drainage facility design. The Manual is intended to be an effective and practical resource that provides users with proven engineering approaches along with illustrative examples. The Manual represents a compilation of a large amount of technical information in a single document, which should help minimize the need for multiple outside references.

It is assumed that the user has basic knowledge of hydraulics, hydrology, and stormwater management concepts. While some theory is presented in the Manual, the text is devoted more to the practical application of the theory, as it relates to drainage management and design.

1.3 Objectives

Drainage, flood control, and water quality protection in the City of Lincoln and its surrounding areas are an integral part of the comprehensive planning process. Drainage represents only one component of a larger urban system. The objectives of the City of Lincoln with respect to drainage, flood control, and water quality protection are to:

- To protect the general health, safety, and welfare of the residents of the City of Lincoln.
- To minimize property damage from flooding; including minimization of localized neighborhood flooding.
- To ensure that new buildings and facilities are free of flood hazard from major and smaller storm runoff events.
- To minimize water quality degradation by limiting the amount of sediment generation and erosion of channels.
- To encourage the retention of open space, particularly along natural drainageways.
- To plan for large and small flooding events by providing both major and minor drainage systems.
- To implement reasonable, cost effective best management practices (BMPs) for sediment control and water quality enhancement.
- To manage stream and drainage channel corridors to promote environmental diversity and to protect buildings and facilities from damage by channel erosion.
- To stabilize channels to, among other things, minimize the disruption of existing infrastructure such as bridges and utility lines.
- To comply with the City of Lincoln National Pollutant Discharge and Elimination System (NPDES) permit requirements.

- To develop equitable methods to adequately fund construction, operation and maintenance, and administration of an up-to-date stormwater management program.
- To minimize future operating and maintenance expenses.
- To educate the public on stormwater policies and administrative procedures.
- To build a stormwater program based on understanding and cooperation with builders and developers, providing for effective administrative authority for the City and LPSNRD.

The strict application of this Manual in the overall planning of new development is practical and economical; however, there are many built-up areas within and around the City of Lincoln which will not conform to the drainage standards proposed in this Manual. In fact, the problems associated with these areas provided some of the impetus for the development of this Manual. The up-grading of built-up areas to conform to the policy, criteria, and standards contained in this Manual may be difficult, and sometimes impractical. Therefore, in the planning of drainage improvements in built-up areas, it is recommended that the design approaches presented in this Manual be adjusted to optimize the benefit to cost ratio.

1.4 Planning Concepts

The following general principles apply when planning for and designing urban storm drainage systems (ASCE, 1992):

1.4.1 Drainage is a Regional Phenomenon

Drainage is a regional phenomenon that does not respect the boundaries between government jurisdictions or between public and private properties. Therefore, a successful plan must integrate regional jurisdictional cooperation, where applicable, to accomplish established goals. The City of Lincoln will seek the cooperation of LPSNRD and Lancaster County to minimize the contribution of all storm drainage systems to flooding and in the preparation and implementation of master drainage plans.

1.4.2 Storm Drainage is a Sub-System of the Total Urban System

Drainage is a sub-system of all urbanization. The planning of drainage facilities must be included in the urbanization process. The first step is to include drainage planning with all regional and local urban master plans.

Stormwater management facilities, such as open channels and storm drains, serve both conveyance and storage functions. When a channel is planned as a conveyance feature, it requires an outlet as well as downstream storage space to adequately contain the design flows. The space requirements for adequate drainage may become a competing use for space with other land uses. If adequate provision is not made in the land use plan for the drainage requirements, stormwater runoff will conflict with other land uses, will result in water damages, and will impair or even disrupt the functioning of other urban systems (Tulsa, 1993).

1.4.3 Urban Areas Have Two Drainage Systems

Urban areas are comprised of two drainage systems. The first is the minor or primary system, which is designed to provide public convenience and to accommodate relatively moderate frequent flows. The other is the major system, which carries more water and operates when the rate or volume of runoff exceeds the capacity of the minor system.

1.4.4 Runoff Routing is a Space Allocation Problem

Analysis and design of drainage systems should not be based on the premise that problems can be transferred from one location to another.

1.4.5 Stormwater Runoff as a Resource

Stormwater runoff and the facilities to accommodate the runoff can be an urban resource when properly included in the urban system. Drainageways can provide environments for various life forms such as aquatic life, mammals, birds, and vegetation. In many cases the drainage facilities can provide areas for active and passive recreation for citizens to enjoy. Although sometimes a liability to urbanization, stormwater runoff can be beneficial as an urban resource (Tulsa, 1993).

When stormwater runoff is treated as a resource, water quality aspects become important. As such, it is important to implement best management practices (both structural and nonstructural) and effective erosion and sediment control measures.

Due to the multi-purpose potential of stormwater runoff, natural drainage channels should be given priority consideration in the preparation of drainage system designs and should be included as an integral part of the landscape.

1.4.6 Utilize the Features and Functions of the Natural Drainage System

Every site contains natural features that may contribute to the management of stormwater under existing conditions. Each development plan should carefully map and identify the natural system. Natural engineering techniques can preserve and enhance the natural features and processes of a site and maximize post-development economic and environmental benefits. Good designs improve the effectiveness of natural systems, rather than negate, replace, or ignore them.

1.4.7 Post-Development Flow Rates Shall Not Exceed Pre-Development Conditions

In new developments, post-development flow rates shall not exceed pre-development conditions. This can be addressed by considering the following: (1) minimizing the amount of directly connected impervious area and (2) controlling the rate of runoff by implementing stormwater management systems which use practices that maintain vegetative and porous land cover, or use of storage facilities..

1.4.8 Design the Stormwater Management System from the Point of Outflow

The downstream conveyance system should be evaluated to ensure that it has sufficient capacity to accept design discharges without adverse backwater impacts on the proposed conveyance system, or downstream impacts such as flooding, streambank erosion, and sediment deposition. Starting tailwater conditions for the major and minor design storm flow should be determined

1.4.9 Provide Regular Maintenance

Failure to provide proper maintenance reduces both the hydraulic capacity and pollutant removal efficiency of the system. Effective maintenance relies on clear assignment of tasks and a regular inspection schedule.

1.4.10 Preventive and Corrective Actions

In existing urban settings, it may be necessary to develop a stormwater management strategy based upon both preventive and corrective measures. For example, structural corrective measures such as inlets, storm drains, interceptor lines, channelized stream sections and reservoirs affect and control storm runoff and floodwaters directly. Nonstructural corrective measures, such as floodproofing and land use adjustments, help limit activities in the path of neighborhood storm runoff or in river floodplains. Preventive actions available for reducing storm runoff and flood losses include: flood-prone land acquisition, floodplain regulations, and control of land uses within flood-prone areas.

1.5 Criteria Summary

1.5.1 Drainage Design and Technical Criteria

The design criteria presented in this Manual are based on national engineering state-of-the-practice for stormwater management, modified to suit the needs of Lincoln specifically. Extensive input from the City of Lincoln, LPSNRD, and the public was used to develop and refine the criteria. The criteria are intended to establish guidelines, standards, and methods for effective planning and design. The criteria should be revised and updated as necessary to reflect advances in the field of urban drainage engineering and urban water resources management.

1.5.2 Minor and Major Drainage Systems

Every urban area has two separate and distinct drainage systems, whether or not they are actually planned for and designed. One is the *minor* system and the other is the *major* system. To provide for orderly urban growth, reduce costs to taxpayers, and obviate loss of life and property damage, both systems must be planned and properly engineered.

1.5.2.1 Minor Drainage System

The minor drainage system is typically thought of as storm drains and related appurtenances, such as inlets, curbs and gutters. The minor system is normally designed for floods with return frequencies of 2-years to 10-years, depending upon the kind of land use. The minor system has also been termed the “convenience” drainage system.

For Lincoln, the minor drainage system design will be based on the 5-year to 10-year return frequency storms, depending on the design application. For residential areas, the 5-year storm is appropriate, while for downtown areas and industrial/commercial areas, the 10-year storm is appropriate.

During design, the hydraulic grade line for all enclosed systems shall be determined to ensure that inlets act as inlets, not outlets. All easements for storm drain pipe should be a minimum of 30 feet wide. In situations where the engineer can clearly demonstrate that an easement less than 30 feet is adequate, the City may consider such a request. Easements for storm drain pipe and surface water flowage shall be used where a drainageway must be maintained to carry stormwater flow in excess of the storm drain pipe capacity. The easement cross-section shall accommodate the depth and width of flow from the 100-year storm. The width must also be designed to allow for access of maintenance equipment during the major storm.

An additional design storm equal to the 2-year frequency shall be used in the design of detention facilities.

1.5.2.2 Major Drainage System

The major drainage system is designed to convey runoff from, and to regulate encroachments for, large, infrequently occurring events. When development planning and design do not properly account for the major storm flow path, floodwaters will seek the path of least resistance, often through individual properties, thus causing damage. An assured route of passage for major storm floodwaters should always be provided such that public and private improvements are not damaged. For subdivisions in Lincoln, this need is to be provided for both in watershed headwaters settings and along major drainageways.

The 100-year return frequency storm shall be the major drainage system design storm for all new developments. Runoff from major storms should pass through a development without flooding buildings or homes. Overland flow routes can be provided using streets, swales, and open space.

Open channels for transportation of major storm runoff are desirable in urban areas and use of such channels is encouraged. Open channel planning and design objectives are best met by using natural, or natural-type channels, which characteristically have slow velocities, and a large width to depth ratio. Optimum benefits from open channels can best be obtained by incorporating parks and greenbelts with the channel layout.

To the extent practicable, open channels should follow the natural channels and should not be filled or straightened significantly. Effort must be made to reduce flood peaks and control erosion so that the natural channel regime is maintained. Channel improvement or stabilization projects are encouraged which minimize use of visible concrete, riprap, or other hard stabilization materials to maintain the riparian characteristics.

1.5.3 Storm Runoff Computation

The calculation of the storm runoff peaks and volumes is important to the proper planning and design of drainage facilities. The calculation of runoff magnitude shall be by either the rational method, the Soil Conservation Service (SCS, now known as the Natural Resource Conservation Service) TR-55 method, or using the SCS method in the U.S. Army Corps of Engineers (USACE) HEC-HMS software.

1.5.4 Detention

Detention facilities shall have release rates which do not exceed the pre-development peak discharge rates for the 2-year, 10-year, and 100-year storms. Hydrologic conditions as of 1 August 1999 shall be used to determine peak release rates for pre-development conditions. Submittal of hydraulic design calculations is required to document that major and minor design storm peak flows are attenuated. On-site and regional facilities shall be designed with adequate access and sediment storage right-of-way (including sediment fore-bays) to facilitate maintenance.

On-site detention is required unless the master planning process or a regional analysis has shown that the detention requirement can be transferred to a regional detention cell. On-site detention, however, may still be necessary to provide for receiving stream channel stability maintenance. To the extent feasible, extended detention design shall be utilized to enhance stormwater quality benefits, including increased sediment removal.

Where feasible, strategically located regional detention cells shall be used to reduce flow peaks from major storm events. Funding mechanisms will be developed to allow joint investment by benefitted parties in regional facilities, where transfer of detention requirements proves to be feasible and beneficial.

On-site and regional detention facilities shall be designed with adequate access and sediment storage right-of-way (including sediment forebays) to facilitate maintenance. Unless private maintenance of on-site detention facilities is acceptably performed, necessary maintenance by government forces shall be provided. The cost of this government service shall be equitably allocated to responsible parties.

The owner shall provide record drawings of the storage facility to the Public Works & Utilities Department.

1.5.5 Streets

The primary drainage functions of streets are to convey nuisance flows quickly and efficiently to the storm drain or open channel drainage with minimal interference to traffic movement and to provide an emergency passageway for the major flood flows with minimal damage to adjoining properties, while allowing for safe movement of emergency vehicles.

The allowable use of streets for new land development in Lincoln for minor and major storms runoff in terms of pavement encroachment is presented in Chapter 3.

1.5.6 Flood Corridor Management

In all watersheds within the Existing Urban Area where a FEMA mapped floodplain has not been delineated, development shall preserve a corridor in channels which drain greater than 150 acres. In all watersheds within New Growth Areas, development shall preserve a corridor in **all** channels which drain greater than 150 acres or have a defined bed and bank.

The width of minimum flood corridors shall be equal to the channel bottom width, plus 60 feet, plus six times the channel depth, and the corridor shall be centered on the channel or aligned such that the corridor follows the natural flow of flood waters.

The corridor will be centered on the channel or aligned such that the corridor follows the natural flow of floodwaters. Riparian vegetation and the existing grade within the identified flood corridors shall be preserved or enhanced to the maximum extent practicable, or mitigated during the development planning and construction processes when impacted by allowable encroachments. Individual areas of encroachments of the riparian vegetation and encroachments of fill into the existing grade will be permitted for operation, maintenance and repair, channel improvements, stormwater storage facilities, and utility crossings. Individual areas of encroachment may also be permitted for parks, pedestrian/bike trails, recreational uses, and public purposes, provided the encroachments are minimal and the uses are generally consistent with the purpose of the corridor.

Sequencing and mitigation for encroachments into Minimum Flood Corridors is required as described in Chapter 2.05 of the Design Standards and Chapter 10 of this manual.

Flood corridors delineated during development of land shall be legally described and recorded.

Through the watershed master planning process, develop approximate 100-year projected future conditions flood profiles for mainstem and tributary channel corridors that are between the limits of detailed study by FIS and the boundary of the uppermost 150-acre sub-basin(s). Once the master plan flood profiles have been accepted by the City, regulate new development along the channel areas so the lowest opening in new buildings is protected from the flood profile.

In watersheds where FIS floodplains have not been delineated and where flood prone areas have not yet been determined through the watershed master planning process, regulate new development so the lowest opening of adjacent new buildings is protected to one foot above the calculated 100-year flood profile.

1.5.7 NPDES Construction Site Activities

A NPDES "notice of intent" and a Stormwater Pollution Prevention Plan (SWPPP) shall be required before land disturbance or vegetation removal activities occur on any site greater than or equal to 1.0 acre in size. The structural and non-structural best management practices (BMPs) are recommended to address stormwater quality enhancement. The SWPPP shall be prepared by a designated erosion control designer. A designated erosion control designer shall be a; licensed professional engineer, architect or landscape architect; a professional in Erosion and Sediment Control, certified by the Soil and Water Conservation Society; or a person with similar erosion and sediment control training and knowledge certified by a nationally recognized erosion and sediment control association. As one condition of approval, a construction schedule shall be included which indicates installation of as many of the proposed BMPs as are feasible before any land disturbing activity is conducted, including site grubbing. The schedule will also indicate a plan to limit the duration of exposure of disturbed land.

Contractors and developers shall contact the City on the business day prior to performing land disturbance or vegetation removal on any site greater than or equal to 1.0 acre. Construction sites will be inspected periodically for compliance with submitted SWPPPs.

1.5.8 Water Quality

Both structural and nonstructural best management practices (BMPs) are recommended that address long-term stormwater quality enhancement. Effective, reasonable, and cost-effective BMPs should be selected for implementation on a site-specific basis and in a manner that is consistent with existing basin master plans. For water quality control purposes, it is recommended that the first 0.5 inches of runoff be captured and detained for a period of at least 24 hours, and preferably longer.

The following is a list of voluntary structural BMPs that should be considered:

- Create temporary ponding areas on parking lots and in landscaped or turfed open areas of building sites;
- Use porous pavement for remote parking areas;
- Reduce the amount of impervious area directly connected to the storm drain system;
- Intentionally create longer vegetated drainage paths for minor storm events;
- Encourage use of constructed wetlands;
- Develop multipurpose extended detention facilities;
- Use retention facilities (wet ponds) where feasible.

The following is a list of voluntary non-structural BMPs that should be encouraged:

- Use of appropriate vegetation to reduce the need for fertilizer and pesticides;
- Preservation of environmentally sensitive areas to protect them from development or other disruption;
- Set aside more open space;
- Preserve or re-establish riparian vegetation;
- Implement staged grading of developments to minimize the amount of land disturbed at one time.

Additional structural and nonstructural BMPs are presented in Chapter 9 of the Manual.

1.6 Interrelationship Between Stormwater Quantity and Quality Management

With urbanization, the hydrology of a watershed changes in three important ways: (1) the total runoff volume is greater, (2) the runoff occurs more rapidly, and (3) the peak discharge is greater. The increase in runoff volume results from the decrease in infiltration and depression storage. The shortened time base results from the greater flow velocities in the drainage system. The increase in peak discharge is the inevitable consequence of a larger runoff volume occurring over a shorter time. This increase in peak discharge for any storm means a related high discharge occurs more frequently (ASCE, 1992).

Receiving water impacts are caused by a combination of physical and chemical effects. Impacts associated with stormwater discharges can be discussed in terms of three general classes: (1) short-term changes in water quality; (2) long-term water quality impacts; and (3) physical impacts. Short-term changes in water quality occur during and shortly after storm events. Long-term impacts are caused by the cumulative effects associated with repeated stormwater discharges. Physical impacts include erosional effects of high stream velocities that occur after the natural hydraulic cycle has been altered. More frequent occurrences of high discharges may cause or intensify channel erosion problems, disrupting the riparian habitat both where the erosion occurs and where the additional sediment is deposited downstream (ASCE, 1992).

The City of Lincoln has seen the consequences of rapid urbanization on the water quality of its receiving streams. Consequently, this Manual is part of an effort to more effectively manage both stormwater quantity and quality. By implementing well planned and designed engineering approaches, the necessary measures can be taken to minimize the cumulative water quality and water quantity impacts that result from urbanization.

1.7 Limitations

The interpretation and application of the provisions in this Manual shall be the minimum requirements for promotion of the health, safety, convenience, order and general welfare of the community. The standards, however, should not be construed as rigid criteria. Rather, the criteria are intended to establish guidelines, standards and methods for sound planning and design. The City may set aside these criteria in the interest of the health, safety, convenience, order and general welfare of the community.

The Manual is not intended to interfere with, abrogate, or annul any other regulation, statute, or other provision of the law. Where any provision of this Manual imposes restrictions different from those imposed by any other provision of this Manual or any other regulation or provision of law, that provision which is more restrictive or imposes higher standards shall govern.

1.8 Updating

The policies and criteria presented in this Manual may be amended as new technology is developed and/or experience is gained in the use of the criteria indicate a need for revision. Amendments and revisions to the Manual will be made by the City of Lincoln when necessary to accomplish the goal of reasonable public protection from surface water runoff.

References

American Society of Civil Engineers, Manuals and Reports of Engineering Practice No. 77. Design and Construction of Urban Stormwater Management Systems. 1992.

City of Tulsa, Oklahoma. Stormwater Management Criteria Manual. 1993

Denver Urban Drainage and Flood Control District. Drainage Criteria Manual, Volume I. March 1969.